

**REMARKS**

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated May 20, 2005. By the present Amendment, the Abstract has been amended to be in the form of a single paragraph that is not more than 150 words. Accordingly, removal of the objection to the abstract is respectfully requested.

In addition, by the present Amendment, claim 51 has been amended to correct the minor informality noted in paragraph 3 of the Office Action. Accordingly, reconsideration and removal of the object to claim 51 is also respectfully requested.

Also by the present amendment, independent claim 51 has been amended to further clarify the invention, and new claims 57-76 have been added to emphasize various features of the invention with different degrees of specificity. The following discussion of the claims will address the distinctions of these claims over the cited prior art to Collins (USP 5,300,460), Ohmi (USP 5,272,417), Lenz (USP 5,609,720), Sakamoto (USP 5,698,062) and Ishii (USP 5,529,657), whether considered alone or in combination with one another. As such, based on the following comments, reconsideration and removal of the 35 USC §103 rejection set forth in the Office Action, and allowance of the newly submitted claims in this application over the cited prior art is respectfully requested.

Briefly, the present amendment is directed to further emphasizing a fundamental distinction of the present invention over all of the cited prior art. For convenience, the following discussion refers to a copy of the disclosure in the in parent USP 6,197,151 which corresponds to the specification of the present

continuation application. Accordingly, reference to the Specification of the parent USP 6,197,151 is respectfully requested in reviewing the following comments.

With regard to the presently pending claims, it is noted that all of these claims are specifically directed to a plasma etching apparatus including a vacuum processing chamber and a pair of electrodes arranged opposite to one another within the vacuum processing chamber. In particular, all of the present claims are directed to resolving a problem stated in column 3, lines 33 to 37 that, with prior art techniques:

"It is difficult to manufacture a fine pattern of 0.2  $\mu\text{m}$  or smaller on a wafer having a diameter larger than 300 mm uniformly and quickly with a high selectivity of the etching material to the base material."

In other words, the present application is specifically directed to improving manufacturing procedures to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller on a wafer having a diameter larger than 300 mm.

The presently pending claims define the structure of a plasma etching apparatus to achieve the etching of a fine pattern of 0.2  $\mu\text{m}$  or smaller on a wafer having a diameter larger than 300 mm uniformly and quickly with a high selectivity. In particular, each of these claims defines the important feature, discovered by the applicants, of using a medium plasma density within a specific range of  $5 \times 10^{10}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  to accomplish this etching of a pattern of 0.2  $\mu\text{m}$  uniformly and quickly with a high selectivity on a wafer of 300 mm or larger. It is respectfully submitted that the use of this specific range was completely unappreciated by the prior art, and was, in fact, discovered by the applicants. The fact that this critical plasma density range was unrecognized by the prior art as an ideal medium range for processing of large wafers of 300 mm or larger to etch a selective fine pattern of 0.2  $\mu\text{m}$  or smaller

is evidenced by the fact that absolutely none of the cited references teaches or suggests this specific critical range for plasma density.

The importance of this critical range is expressed in the Specification (again referring to the '151 parent patent) as follows:

"In order to improve the microworkability of a large diameter sample [referring to the 300 mm or larger sample discussed throughout the Specification], it is preferable that a plasma generating high frequency electric power source 16 having a high frequency is used to attempt to stabilize discharge in a lower pressure region. In the present invention, the plasma generating high frequency electric power source 16 is connected to the upper electrode 12 in order to obtain a plasma which is a lower pressure of 0.4 Pa to 4.0 Pa and a plasma density of  $5 \times 10^{10}$  to  $5 \times 10^{11} \text{ cm}^{-3}$ , and dissociation of the processing gas is not excessively progressed and has a uniform and large diameter.

New independent claim 57 specifically defines the critical features noted above in terms of:

" means for generating a plasma with a density of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  between said pair of electrodes to provide a substantially uniform plasma over said sample having a diameter of 300 mm or more to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller on said sample;"

In other words, newly presented independent claim 57 specifically defines that the invention is directed to samples having a diameter of 300 mm or more with the means for generating the plasma in the critical range of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  being provided to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller on the sample.

It is respectfully submitted that absolutely none of the cited references to Collins, Ohmi, Lenz, Sakamoto or Ishii teach or suggest this critical range of plasma density of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  for wafers of 300 mm or larger to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller on the sample. Quite to the contrary, both of the cited primary references to Collins and Ohmi deal with smaller diameter samples and,

given the technology during the time period of filing of the Collins and Ohmi patent applications, much larger patterns. For example, in a corresponding Japanese Application (JP1-119651), Ohmi discloses a pattern size of 0.5  $\mu\text{m}$ , which was quite common at that time.

Thus, in comparing the invention defined by claim 57 with both of the primary references to Collins and Ohmi, it can be seen that:

- "(1) Neither Collins nor Ohmi teach or suggest the critical range of plasma density of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  for the processing;
- (2) neither Collins nor Ohmi deal with samples having a diameter of 300 mm or larger;
- (3) neither Collins nor Ohmi teach or suggest the etching of a fine pattern of 0.2  $\mu\text{m}$  or smaller on the sample.

As such, it is respectfully submitted that it would take a complete modification of either Collins or Ohmi to arrive at the present claimed invention. In particular, it is respectfully submitted that there is no motivation, other than applicants own disclosure, for performing this complete modification of Collins or Ohmi which would be required to arrive at the present claimed invention.

In the first place, although one might be able to set all of the parameters within the general ranges taught by Collins and Ohmi to arrive at a plasma density of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$ , the fact is that neither Collins nor Ohmi has any recognition that this is a critical range for the plasma density. Therefore, one following the teachings Collins an Ohmi might arrive at such a range or might arrive at a completely different range. In fact, at that time, it was general practice to seek a much higher plasma density than the claimed range (which is a medium plasma density), especially when dealing with smaller wafers such as taught by Collins and Ohmi.

In the Office Action, it is stated that it would be obvious to modify either Collins or Ohmi to use larger wafers of 300 mm or greater, and, further, that the claimed range of plasma density would be inherent within the various ranges for power, gap and pressure set forth in both Collins and Ohmi. In response to this, applicants respectfully submit that, in fact, working with smaller wafers having larger patterns such as is the case in both Collins and Ohmi is quite different than working with larger wafers of 300 mm or greater having smaller patterns of 0.2  $\mu\text{m}$  or less. In particular, when dealing with smaller wafers, a smaller overall chamber size is utilized. Within the smaller chambers of Collins and Ohmi, one could set the same values defined in claim 51, for example, for the frequency, gap and pressure, and still arrive at a plasma density different than that defined by the present range of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$ . Without a recognition of the criticality of this range, there is simply no basis in these references for making all of the specific settings which would be necessary to achieve it, particularly considering the fact that both Collins and Ohmi provide systems for smaller wafers having larger patterns located in smaller chambers.

A useful case to consider on this issue is the case of *In re Antonie*, 195 USPQ 6 (CCPA 1977). In that case, It was determined that several variables were important for the device including the throughput, a contactor area, and a tank volume. The Examiner had argued that increasing the ration of the tank volume to the surface area to increase efficiency and working out a value for optimum efficiency would be a mere matter of mechanical experimentation. In response to this, the CCPA stated:

" The PTO in the minority appear to argue that it would always be obvious for one of ordinary skill in the art to try varying every parameter of the system in

order to optimize the effectiveness of the system. Even if there is no evidence in the record that the prior art recognized that particular parameter affected the result. As we have said many times, obvious to try is not the standard of 35 USC §103. ... An over emphasis on the routine nature of the data gathering required to arrive at the applicants discovery, after its existence became expected, overlooks the last sentence of Section 103." 195 USPQ at 8 (emphasis original)

It is noted that the CAFC has also stated this same rule, following the CCPA, for example, In re Fine, 5USPQ 2d 1596 . In particular, the CAFC stated in In re Fine:

"The Eads and Warnick references disclosed at most that one skilled in the art might find it obvious to try the claimed invention. But whether a particular combination might be "obvious to try" is not a legitimate test of patentability." 5USPQ 2d 1599.

In the present instance, it is respectfully submitted that a very similar situation exists. In the first place, the applicants invention now clearly defines, in all the independent claims, that it is dealing with samples of 300 mm or greater to etch patterns of 0.2  $\mu\text{m}$  or less. Neither Collins nor Ohmi deal with these specific parameters of the sample. In addition, each of the independent claims particularly defines the critical medium plasma range of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  to achieve the desired improved microworkability (column 14, line 46 of the '151 patent) and the uniform and quick etching with high selectivity (col. 3, line 34 et seq.) for such large wafers with such small patterns. As such, it is respectfully submitted that any attempt to modify Collins and Ohmi to change the size of the wafer and the pattern size that is being etched, and then to adjust all of the factors within the larger chamber size which would be necessitated to arrive at the claimed critical range for plasma density is clearly the same type of "obvious to try" rationale found to be improper by both the CCPA and the CAFC in the respective cases of In re Antonie and In re Fine. Therefore, reconsideration of newly submitted independent claim 57, which specifically defines the feature of the critical plasma density range for the large

300 mm or greater diameter wafers with the fine pattern of 0.2  $\mu\text{m}$  or less is respectfully requested.

Reconsideration and allowance of newly submitted independent claim 66 is also respectfully requested. Independent claim 66 contains all features of the above-discussed claim 57, as well as the further feature of means for setting the atmospheric pressure inside the vacuum processing chamber to 0.4 Pa to 4.0 Pa to generate the plasma for etching the fine pattern. As discussed in column 2, line 61 et seq. of the parent '151 patent, in the Prior Art:

"It is difficult to produce a plasma having a desired density higher than nearly  $5 \times 10^{10} \text{ cm}^{-3}$  under a pressure condition of 0.4 Pa to 4.0 Pa."

Similarly, such difficulties in the Prior Art are further noted in column 3, lines 29 et seq. in stating:

"It is difficult to obtain a uniform plasma density of  $5 \times 10^{10} \text{ cm}^{-3}$  over the surface of the sample having a diameter of 300 mm or more under a pressure condition as low as 0.4 Pa to 4.0 Pa.

Immediately following this, the difficulty in the Prior Art of manufacturing a fine pattern of 0.2  $\mu\text{m}$  or smaller on a wafer having a diameter larger than 300 mm uniformly and quickly with a high selectivity is noted.

With regard to the present invention, column 14, line 50 et seq. specifically points out the connection between the low pressure range of 0.4 Pa to 4.0 Pa and the critical plasma density range discussed above with regard to claim 57 as follows:

"In the present invention, the plasma generating high frequency power source 16 is connected to the upper electrode in order to obtain a plasma which is a low pressure of 0.4 Pa to 4.0 Pa and a plasma density  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$ , and dissociation of the processing gas is not excessively progressed and has a uniform and large diameter. "

As such, this specification clearly notes the inter-relationship between the low pressure range of 0.4 Pa to 4.0 Pa and the critical plasma density range of  $5 \times 10^{10} \text{ cm}^{-3}$  to  $5 \times 10^{11} \text{ cm}^{-3}$  for etching fine pattern of 0.2  $\mu\text{m}$  or smaller on a large size wafer having a diameter of 300 mm or more.

Turning again to the cited Prior Art, particularly the primary references to Collins and Ohmi, the Office Action points out that the specific range of 0.4 Pa to 4.0 Pa can be found within the broader general pressure ranges of these references. However, once again, it is respectfully submitted that the logic of selecting this specific low pressure range (which is not recognized by the references) to generate a specific critical plasma density range (which is also not recognized by the references) is clearly the same type of "obvious to try" rationale specifically prohibited by the cases of *In re Antonie* and *In re Fine*, particularly when one considers that these references do not deal with large wafers having a diameter of 300 mm or more to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller, as defined by claim 66. Accordingly, careful reconsideration and allowance of new independent claim 66 is also respectfully requested.

Reconsideration and allowance of previously pending claim 51, as now amended, is also respectfully requested. Independent claim 51 contains all limitations of the above discussed claims 57 and 66. With regard to this, it is noted that claim 51 has been amended to specifically define that the critical plasma range is generated "to etch a fine pattern of 0.2  $\mu\text{m}$  or smaller on said sample." As such, claim 51 now clearly also defines the same distinctions over the cited Prior Art, particularly the primary references to Collins and Ohmi, in terms of providing

optimized processing parameters for a large diameter sample of 300 mm or more to etch a fine pattern of 0.2  $\mu$ m or smaller.

In addition, claim 51 continues to define the specific additional parameters (other than the critical plasma density range and the low pressure defined in claim 66) of applying a high frequency electric power of 30 MHz to 300 MHz between a pair of electrodes having a gap set to 30 MM to 100 MM. As such, claim 51 defines all of the parameters specified in column 14, lines 46 through 60 for the frequency, electrode gap, low pressure range and critical plasma density range for providing a uniform and large diameter plasma which will improve microworkability of a large diameter sample to etch a fine pattern of 0.2  $\mu$ m or smaller on the large diameter sample. As such, any attempt to read the references of Collins and Ohmi whether considered alone or in combination with one another or the other cited Prior Art, represents an even further example of the "obvious to try" rationale prohibited by the courts in In re Antonie and In re Fine since, once again, the selection of these specific ranges for frequency and electrode gap is not recognized by any of the cited Prior Art. Instead, only broad ranges are provided by the cited Prior Art, with no recognition of the particular selection of the four ranges defined by claim 51 to provide optimized processing for etching a fine pattern of 0.2  $\mu$ m or smaller on a sample of 300 mm or larger diameter (which neither of the primary references to Collins or Ohmi address). Therefore, careful reconsideration and allowance of independent claim 51 is also respectfully requested.

Reconsideration and allowance of newly submitted independent claim 75 is also respectfully requested. Claim 75 defines all features of claim 51 discussed above. In addition, claim 75 defines a further feature of:

"A magnetic field forming means forming means for forming a magnetic field designed to generate increased plasma at the portion within an outer periphery of said sample which is greater than the plasma at the center of said sample, the magnetic field forming means producing an intensity of the magnetic field on said sample smaller than 30 gauss."

This feature of the magnetic field forming means is directed to a problem discussed, for example, in column 3, line 53 et seq. of the parent '151 patent that:

"Further, the plasma-processing apparatus is generally constructed in such a manner that the processing gas is exhausted from the peripheral portion of a sample. In such a case, there is a disadvantage in that the plasma density is higher in the central portion of the sample and lower in the peripheral portion of the sample, and accordingly uniformity in the processing all over the surface of the sample is degraded. "

In order to overcome this problem, column 24, line 33 et seq. of the parent '151 patent teaches:

"In order to perform plasma-processing all over the surface of the sample highly accurately, cyclotron resonance effect of electrons is larger in the peripheral portion or the portion outside of the peripheral portion than in the center so that generation of plasma becomes large in the peripheral portion or the portion outside of the peripheral portion of the sample than in the center of the sample."

Similarly, in column 25, line 45 et seq., it is stated:

"The distribution of the magnetic field intensity for each portion of the sample surface can be adjusted by appropriately choosing the position and the diameter of the coils 210, 220 so as to increase plasma generation in the periphery or outer side of the periphery of the sample.

As such, claim 75 defines not only the distinctions discussed above concerning the other independent claims, including claim 51, but also the further distinction of the magnetic field forming means to increase the plasma at the outer periphery to overcome the problem noted in column 3, line 53 et seq. of the parent '151 patent of a non-uniform plasma over the surface of the sample. This is completely unsuggested by any of the cited references in the application. Therefore,

reconsideration and allowance of independent claim 75 over the cited prior art is respectfully requested.

Finally, reconsideration and allowance of the dependent claims 43, 46, 47, 50, 53, 55, 56, 58 to 65, 67 to 74 and 76 to 78 is respectfully requested. It is noted that these claims define further detailed features of the present invention serving to even further define the invention over the cited Prior Art. As examples, claim 55 defines the specific setting of the gap of claim 51 to effectively decrease the amount of fluorine in the plasma near the sample. Claim 56 defines an even further specific preferred atmospheric pressure range of 1.0 Pa to 4.0 Pa as discussed, for example, in column 16, line 18-22 as an ideal range to suppress the excessive dissociation of gas and increase plasma density. Claims such as dependent claims 64 define a specific thickness of an insulator between the susceptor cover and the sample table while claim 76 defines that the vacuum processing chamber improves the workability of a sample at a plasma density within the defined critical range of  $5 \times 10^{10} \text{ cm}^{-3}$  and  $5 \times 10^{11} \text{ cm}^{-3}$ . Finally, claims 77 and 78 more specifically define the magnetic field forming means as including a pair of coils each having a position and a diameter to generate increased plasma at the outer periphery of the sample, as discussed on column 25, lines 45 et seq. of the parent '171 " patent. It is urged that these claims serve to even more specifically define over the cited Prior Art, and, accordingly, reconsideration and allowance of these dependent claims is respectfully requested.

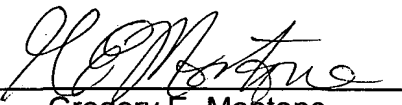
If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

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To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Docket No. 520.35237VX3), and please credit any excess fees to such Deposit Account.

Respectfully submitted,  
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